(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 580 208 A2**

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: **93201947.4**

(22) Date of filing: **02.07.93**

(51) Int. Cl.5: **H02K 1/02**, H02K 1/24

(30) Priority: **20.07.92 US 915584**

(43) Date of publication of application:
26.01.94 Bulletin 94/04

(84) Designated Contracting States:
DE FR GB

(71) Applicant: **GENERAL MOTORS CORPORATION**
General Motors Building
3044 West Grand Boulevard
Detroit Michigan 48202(US)

(72) Inventor: **Ward, Robert Walter**
3701 Ironwood Way
Anderson, Indiana 46011(US)
Inventor: **Boys, William Edward**
3705 Sloan Avenue
Anderson, Indiana 46013(US)
Inventor: **Parker, Sam Brown**
1810 East 49th Street
Anderson, Indiana 46013(US)

(74) Representative: **Jehan, Robert et al**
Patent Section,
1st Floor,
Gideon House,
28 Chapel Street
Luton, Bedfordshire LU1 2SE (GB)

(54) **Alternating current generator rotor.**

(57) A rotor for an alternating current generator of the Lundell type has a shaft (24) which carries two segments (10,12) which have interleaved pole teeth (14,36). The rotor has a core (18) and a field coil (42) disposed about the core (18). The segments (10,12) and/or core (18) are formed of compressed powder iron particles having a particle size in a range of about 10 to 250 micrometres. In the manufacture of the core (18) and/or segments (10,12) the iron powder particles are coated with a thermoplastics material and this thermoplastic coated iron particle material is compacted in the moulding dies of a press. After compaction to the desired shape, the part is sintered at a temperature of about 1121 °C (2050 °F) to burn off the thermoplastic material coating the iron particles.

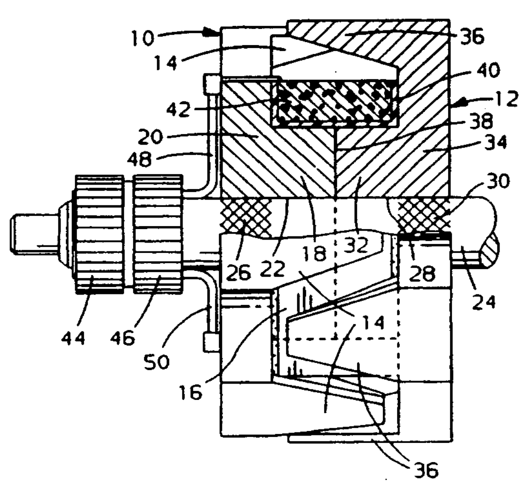

FIG. 1

EP 0 580 208 A2

This invention relates to a rotor for an alternating current generator.

Alternating current generators of the Lundell type are well known to those skilled in the art, one example being the rotor disclosed in US-A-4,588,915. The pole segments and rotor core which are part of the rotor are formed of steel. More specifically, the segments are formed from sheet steel material and the core is formed as a headed steel part.

The present invention seeks to provide an improved rotor.

According to an aspect of the present invention, there is provided a rotor for an alternating current generator as specified in claim 1.

This invention can provide a rotor in which some or all of the metallic magnetic components of the rotor may be formed of compressed iron particles. More specifically, the magnetic components of the rotor may be formed by a method or process in which iron particles having a particle size in a range of about 10 to 250 micrometres are coated with a thermoplastics material.

The coated particles are preferably then compacted or pressed to shape at a pressure of about 618MPa to 772MPa (40 to 50 tons per square inch) in a heated mould die of a press. The thermoplastics material acts as a lubricant during the compacting or pressing operation.

When a magnetic component or part of the rotor has been pressed to shape, the part is then preferably sintered at a temperature of about 1121°C (2050°F). During this sintering operation, the tacky thermoplastics material coating the particles and binding them together is burned or driven-off due to the high temperature of the sintering operation. During sintering, the thermoplastics coating material is burned-off and, in addition, the iron particles become fused together.

In a preferred embodiment, there is provided an alternating current generator of the Lundell type where the segments and/or core of the generator are formed of coated iron particles which have been pressed to shape and sintered in the above manner.

An embodiment of the present invention is described below, by way of example only, with reference to the accompanying drawing, in which:

Figure 1 is a side view in partial cross-section of an embodiment of rotor for an alternating current generator;

Figure 2 is a perspective view of a rotor segment of the rotor shown in Figure 1; and

Figure 3 is a side view in partial cross-section of a second embodiment of rotor for an alternating current generator.

Referring to Figure 1, the embodiment of rotor for an alternating current generator has two poles or segments 10 and 12 which are substantially identical, the segment 10 being shown in perspective in Figure 2. As illustrated in Figure 2, segment 10 has six circumferentially spaced pole teeth or fingers 14. The pole teeth 14 are separated by notches 16. The segment 10 has a cylindrical core portion 18 extending axially from an end wall portion 20. The segment 10 has a central cylindrical bore or hole 22.

Referring to Figure 1, the segment 10 is secured to a shaft 24 of the rotor. This is accomplished by a knurled portion 26.

The segment 12 has a central cylindrical bore 28 disposed about shaft 24 and secured to shaft 24 by knurled portion 30. Segment 12 has a cylindrical core portion 32 extending axially from end wall portion 34. The segment 12 further has six circumferentially spaced pole teeth or fingers 36 separated by notches. The pole teeth 14 are interleaved with the pole teeth 36; that is, the pole teeth of one of the segments are disposed between the pole teeth of the other segment, in known manner.

The inner end face of cylindrical portions 18 and 32 abut or engage each other along interface 38. The cylindrical core portions 18 and 32 form a rotor core. A field coil assembly is disposed about this rotor core. This field coil assembly comprises a spool 40 formed of electrical insulating material which carries a field coil 42 formed of a number of turns of wire. The ends of field coil 42 are connected to respective metallic slip rings 44 and 46 by conductors 48 and 50. The slip rings 44 and 46 are carried by rotor shaft 24 and are electrically insulated from the shaft and each other in a manner known to those skilled in the art.

Referring now to Figure 3, a modified alternating current generator rotor is illustrated. The rotor of Figure 3 has two segments 54 and 56 and a core 58 which is separate from segments 54 and 56. Segments 54 and 56 are secured to rotor shaft 60 as is rotor core 58. Core 58 has a central bore or opening 62 for receiving rotor shaft 60.

The segment 54 has a plurality of circumferentially spaced pole teeth 64 which are interleaved with the circumferentially spaced pole teeth 66 of segment 56. The opposite end faces of core 58 engage or abut inside surfaces of segments 54 and 56.

The rotor of Figure 3 has a field coil assembly which includes a spool 68 formed of electrical insulating material. Spool 68 carries a field coil 70 formed of a number of turns of wire.

The opposite ends of field coil 70 are connected respectively to metallic slip rings 72 and 74 by conductors 76 and 78.

The magnetic material utilised for segments 10 and 12 and an embodiment of method of manufacture of the segments 10 and 12 will now be de-

scribed.

The segments 10 and 12 are formed of small size iron powder particles. By way of example and not by way of limitation, the iron powder particles may be a Hoganaes 1000-C iron powder. The particle sizes of the iron particles may range from about 44 to 250 micrometres. However, a very small percentage of the powder may have a particle size as small as 10 micrometres. The powder is about 99.7% Fe, 0.003% C, 0.0005% N, 0.006% S and 0.004% P.

In an embodiment of method of manufacture of segments 10 and 12, the iron powder particles are coated with a thermoplastic material which may be, for example, a polyphenylene oxide supplied by General Electric under the trade name Noryl. One way of accomplishing this is to mix the thermoplastic material with a solvent to provide a liquid material. The iron powder is then blown by air through a vertical tube and at the same time, the liquid material is sprayed on the powder to coat the powder particles. The coated powder falls outside of the tube and is directed back into an inlet of the tube where it is blown up again and coated again. After a number of passes through the tube, the particles are all coated to the desired extent. The solvent evaporates or is recovered during this process.

After the iron particles have been coated, as described, a quantity of the coated iron powder is fed into a die or mould of a press. The shape of the die or mould is configured to provide the shape of segments 10 and 12. The proportions of iron powder and thermoplastic material used may be, by weight, about 99.0% to 99.9% iron powder and 0.1% to 1.0% thermoplastic material. During this feeding operation, the coated iron powder is heated to about 165 to 193 °C (330 to 380 °F). Further, the die or mould is heated to about 288 to 316 °C (550 to 600 °F). With the material in the mould or die, it is compressed at a pressure of about 618 to 772 MPa (40 to 50 tons per square inch) for about 6 to 12 seconds. The thermoplastic material takes on a tacky state during this operation.

During the compression moulding, the thermoplastic material operates as a lubricant which increases the density of the moulded or pressed segment. The density will exceed 7.4 grams per cubic centimetre and is substantially constant throughout the critical strength areas of the segment.

After the segment has been compression moulded as has been described, the compressed segment is sintered at a temperature of about 1121 °C (2050 °F) for about 15 to 45 minutes. The thermoplastic material that coats or encapsulates the iron powder particles is burned-off during the sintering operation due to the high temperature of the sintering operation. Thus, the iron powder particles no longer have a thermoplastic coating since the thermoplastic coating has been burned or driven off. Further, during sintering, the iron particles have a tendency to fuse together.

In the rotor shown in Figure 3, the core 58 is formed of the same material as segments 10 and 12 and the core 58 is formed by the same process as has been described in connection with the process for making the segments 10 and 12. In Figure 3, the segments 54 and 56 are formed of conventional steel magnetic material. Thus, segments 54 and 56 are not formed of powdered iron particles.

With regard to the rotor shown in Figure 3, it will be appreciated that segments 54 and 56 and rotor core 58 could all be formed of powdered iron; that is, of the same material used for segments 10 and 12. Further, segments 54 and 56 can be made by the same process as has been described in connection with the process of manufacturing segments 10 and 12.

Alternatively, the segments 54 and 56 can be formed of powdered iron with the core 58 being formed of steel.

One of the advantages of using compressed iron powder particles to form the segments of the rotor, the pole teeth of the rotor, such as pole teeth 14, can be formed into intricate shapes simply by compression moulding. Moreover, the cylindrical integral core parts 18 can be formed by compression moulding. Further, this can eliminate the need for heavy piercing and forming equipment associated with manufacturing rotor parts for Lundell-type rotors from rather heavy gauge sheet steel.

It can be appreciated that the field coils 42 and 70 form a flux generating means for the rotor in a manner well known to those skilled in the art when they are energised by direct current. Further, the core parts 18 and 32 (Figure 1) and the core 58 (Figure 3) form a magnetic circuit for carrying flux developed by field coils 42 and 70.

The disclosures in United States patent application No 915,584, from which this application claims priority, and in the abstract accompanying this application are incorporated herein by reference.

Claims

1. A rotor for an alternating current generator comprising a shaft (24), first and second segments (10,12) carried by the shaft, the first segment (10) including a plurality of circumferentially spaced and axially extending first pole teeth (14), the second segment (12) including a plurality of circumferentially spaced and axially extending second pole teeth (36) interleaved with the first pole teeth, and a core

(18) disposed between the first and second segments, the core and/or one or both of the first and second segments being formed of compacted iron powder particles having a particle size in a range of substantially 10 to 250 micrometres which have been coated with a thermoplastics material and sintered at a temperature sufficient to burn off the thermoplastics material.

2. A rotor according to claim 1, wherein the first segment includes a first substantially cylindrical axially extending core portion (18) and the second segment includes a second cylindrical axially extending core portion (32), the first and second core portions forming the core.

3. A rotor according to claim 1, wherein the core includes opposed end surfaces which respectively abut the first and second segments.

4. A rotor according to claim 1, 2 or 3, wherein the core and/or one or both of the first and second segments are formed of magnetic material.

5. A rotor according to any preceding claim, wherein the compacted iron powder particles are sintered at a temperature of substantially 1120 degrees Centigrade.

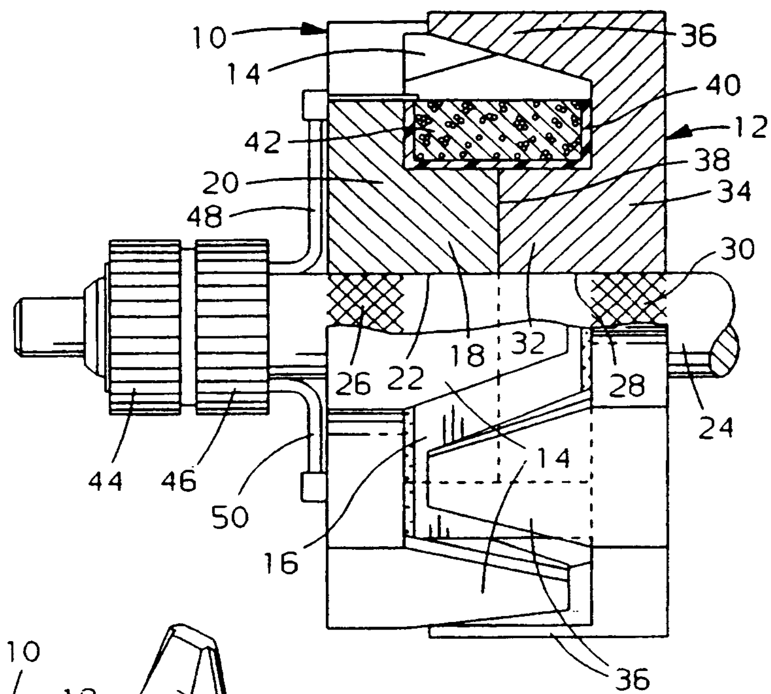

FIG. 1

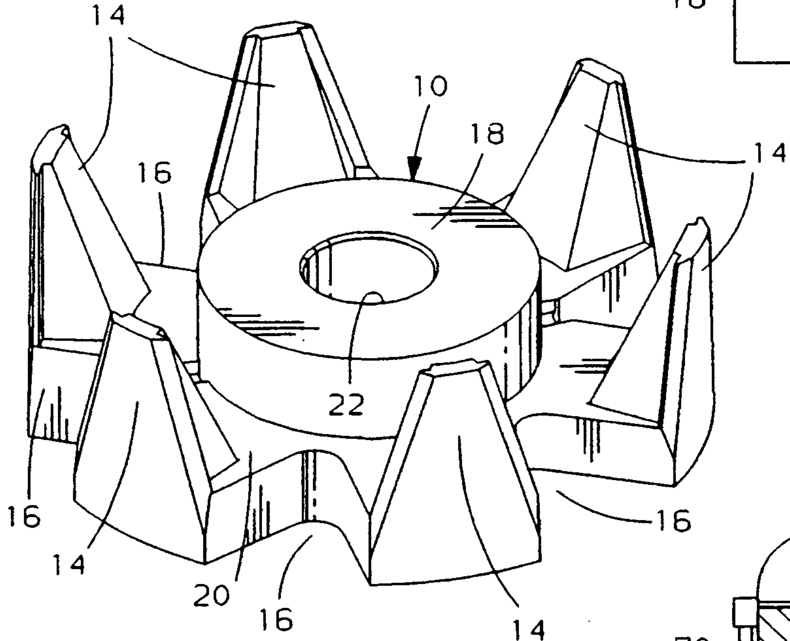

FIG. 2

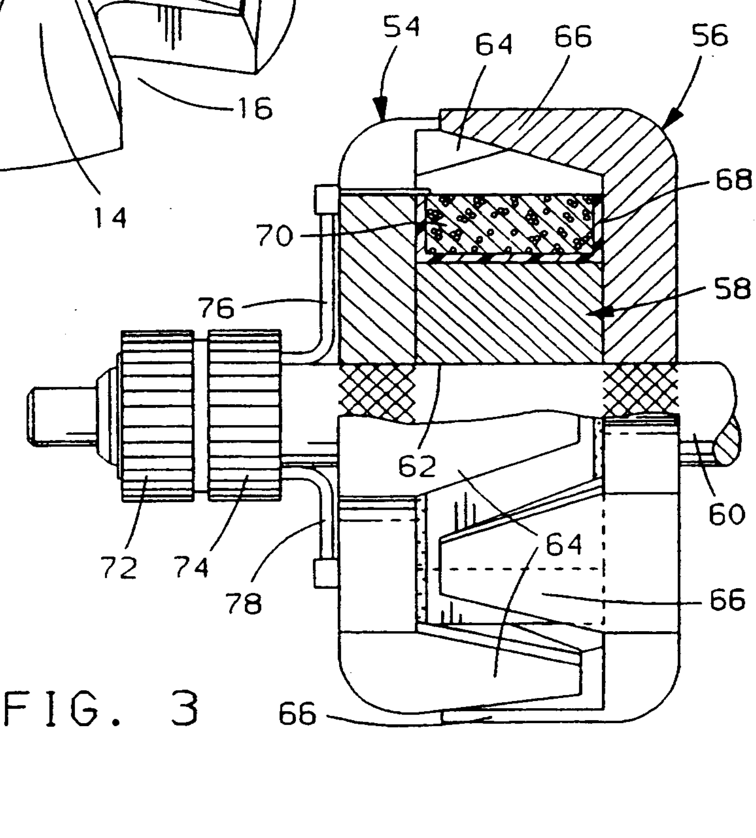

FIG. 3